EXPLANATORY NOTES

ON THE

EXHIBITS

TO THE

WORLD'S COLUMBIAN EXPOSITION

AT

CHICAGO, U. S. A.

1893.

CENTRAL METEOROLOGICAL OBSERVATORY
OF JAPAN.

TOKIO.

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INTRODUCTION.

The Central Meteorological Observatory of Japan was founded in 1875 in the Section of Land Survey of the Geographical Bureau, Home Department at *Tokio.* After undergoing several vicissitudes, the Observatory became independent on August 3rd 1887 and was placed under a direct supervision of the Minister of State for Home Affairs, authorized by the Imperial Ordinance No. XLI regarding meteorological observatory and stations; henceforth its administrative organization was promulgated by the Imperial Ordinance No. CLVI on August 2nd 1890. As prescribed in the later notification, the Central Meteorological Observatory controls meteorological affairs of the Empire, takes charge of the investigation of its meteorology and issues weather forecasts and storm warnings.

The operations of the Observatory are divided into three branches, viz., Service of Observations, Service of Statistics and Service of Indications.

The business to be transacted in the service of Observations is the following:

Tokio meteorological observations,
Earthquake observations,
Observations of atmospheric electricity,
Observations of terrestrial magnetism,
Examinations of micro-organisms and impurities in air,
Verifications of meteorological instruments.

The Service of Statistics investigates and prepares the following reports:

Meteorological reports of stations,
Meteorological reports of lighthouses,
Meteorological reports of ships,
Reports on earthquakes,
Reports on precipitation and temperature at minor stations,
Reports on thunderstorm,
Reports on phenology,

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In the Service of Indications the following business is performed:

Weather forecasts,
Storm warnings,
Meteorological signals.

Our present high officials are

Director:

Titular Meteorologist,	K. Kobayashi.

Chief of the Service of Statistics:

Titular Meteorologist,	K. Nakamura, *Rigakushi.*

Chief of the Service of Indications:

Titular Meteorologist,	Y. Wada, *Rigakushi.*

Chief of the Service of Observations:

Titular Meteorologist probationer,	H. Masato.

The Exhibits of the Observatory to the World's Columbian Exposition of Chicago are as follows:

Organization of the meteorological system in Japan.
Diagram showing the increase of meteorological stations in Japan.
Chart of meteorological and signal stations and lighthouses (reporting meteorological observations) of Japan.
Report of the meteorological observations at Tokio, 1876-1890.
Report of the meteorological observations in Japan, 1886-1890.
Report on earthquake observations in Japan, 1885-1890.
Specimen of Tri-daily Weathermaps.
Reports on the areas of low and high pressure in Japan, 1883-1890.
Charts showing seasonal distributions of air pressure and wind over Japan.
Charts showing seasonal distributions of air temperature and weather over Japan.
Charts showing seasonal distributions of amount of precipitation over Japan.
Charts showing frequency of earthquakes in Japan, the great earthquakes of *Kumamoto* and *Mino-Owari.*
The climate of Japan.
Report on high level meteorological observations in Japan.

I. Organization of the Meteorological system in Japan.

It is mentioned in a certain official record the regular observations once a day were commenced in August of the year 1835 at the Government Astronomical Observatory in *Yedo* (namely Tokio) and that the instruments used were only the barometer and thermometer which have been presented from the Dutch Government to the *Shogun* of that day; it is perhaps the first instrumental meteorological observations made in our country. Unfortunately all the results of these valuable observations were missed, by the commotion of the Great Restoration of *Meiji* Era, thereupon as we have considered it proper to count the outset of our meteorological affairs from the year 1872, this volume has been prepared so as to summarize an account of all the facts and events happened on our meteorological works in the course of twenty one years, 1872-1892. In this not a long period, all things have progressed notably in our country; especially on the meteorological works, despite the business quite newly founded, has been made a noteworthy improvement now-a-days. All the laws and rules concerning the methods and calculations of observations and reports, and the organizations of the Central Observatory as well as of Provincial Stations are also contained in this volume.

Among historical account of our Observatory the followings are the most important:

1875, 1st June: Establishment of the Observatory.
1877, 1st April: Commencement of international simultaneous observations.
1882, 1st July: Adoption of metric system.
1883, 16th February: Opening of weather telegraphy once a day and weathermaps first published.
1883, 26th May: Warning telegraphs first issued.
1883, 19th July: Rules for storm signals notified.
1883, 12th August: Foreign telegrams received for the first time.
1883, 1st November: First signal mast erected at *Shinagawa*, (near Tokio).
1884, 1st July: Commencement of tri-daily meteorological telegrams and weathermaps published.

1886, 1st January: Hourly observations commenced at *Tokio.*
1887, 3rd August: Imperial Ordinance referring to the meteorological observatory and meteorological stations promulgated.
1887, 10th August: Ministerial notification concerning the execution of the above decree.
1887, 11th November: Fifty one provincial stations appointed.
1888, 10th March: Weather indications first issued.
1888, 31st March: I. Arai, the Director, placed on the Retired List and K. Kobayashi succeeded the post.
1890, 2nd August: Administrative organization of the Observatory promulgated.
1892, 5th May: Ministerial notification concerning the execution of the decree referring to the Observatory and stations revised.
1892, 1st July: Rules for meteorological signals and local weather indications decided.

II. Diagram showing the increase of meteorological stations in Japan.

Although meteorological station was first erected in 1872 as mentioned in "*Organization of the meteorological system*", since the importance of the meteorological observations was not appreciated by the public, number of existing stations at the end of the year 1878, that is in the period of seven years, did hardly exceed four throughout the Empire. But in the course of five years since 1879, as the necessity of meteorological observations has been much recognized and on account of an execution of storm warnings had to be proposed, a rapid increase of stations has been a striking fact, the number reaching twenty three in all. Since then the regulation relating to the resources of meteorological services was sanctioned by *His Majesty* the Emperor and the positions of stations appointed by the Minister of Home Affairs. All these steps conjointly influenced a sudden rise in the number of stations, so that in 1889 six were added to the list, eight in 1890; thus we had, in the close of the year 1891, forty six stations in the Empire including ten stations established during the years 1884-1888. Of course these are not sufficient for our purpose, yet we might dare to presume that, in spite of a newly introduced service, it will be a rare example not so often experienced in other countries to make any such striding progress in the course of only twenty years.

III. Chart of meteorological and signal stations and lighthouses of Japan.

Japan is situated between 24° 5′ and 50° 56′ of North Latitude, 122° 45′ and 156° 32′ of East Longitude. Her principal parts lie between 26° and 45° of Latitude, 146° and 128° in Longitude, amongst which the most important are *Honshu* (Nippon), *Kiushu* and *Shikoku*. The remotest stations are *Naha* (26° N.) in the south, *Soya* (46° N.) in the north, *Naha* (128° E.) in the west, and *Nemuro* (145° E.) in the east. When we compute the ratio of the number of existing meteorological stations to the area of our country, we will obtain in average one station in every 8,006 square kilometres.

In the number stated above, nine Stations are of the first order, that is, making hourly observations, and thirty seven of the second order which execute six daily observations at 2^h, 6^h, 10^h, am and pm. Besides, there are fifty lighthouses, lightships and lightstaffs making the same six daily observations as the stations of the second order; but they are so many grouped in some coasts, whilst along the West and North coasts we find a great gap.

At present Temperature and Rainfall Stations are two hundred and two in number, Temperature Stations one hundred and forty four, Rainfall Stations fifty.

As we have already made full allusion to in "*Organization of the meteorological system*", the rules regarding storm signals was prescribed in 1883; thereafter at the end of the year 1891, the number of Signal Stations reached sixty three. If we calculate this number so as to be proportioned to the length of our coast, we will find a ratio approximately of one Signal Station in every 250 kilometres. Hitherto signal stations have been erected mostly in ports frequented by steamers, so there is a further need to extend it also to fishing villages, the project of which would be achieved by and by with an elongation of telegraphic lines.

IV. Report of the meteorological observations at Tokio 1876-1890.

The Central Meteorological Observatory was established in 1875. At that time, observations were made only tri-daily, viz. at $9^h\ 30^m$ am, $3^h 30^m$ pm and $9^h 30^m$ pm; on January 1st 1878, they were increased to tri-hourly, that is, at 3^h am, 6^h am, 9^h am, noon, 3^h pm, 6^h pm, 9^h pm and midnight; on January 1st 1885, hourly observations were commenced in lieu of them, that system continuing yet now. This report contains the results of meteorological observations during the period of 15 years, from 1875 to 1890; its principal subjects being air pressure, air temperature, tension of vapour, relative humidity, wind direction, wind velocity, cloud amount, duration of sunshine, earth temperature, maximum solar radiation, minimum terrestrial radiation, precipitation, evaporation and ozone amount with all their changes, and miscellaneous remarks; also several reports such as on high level observations of Mount *Fuji*, *Gozaishodake* and *Ontake*, together with other special reports.

V. Report of the meteorological observations in Japan, 1886-1890.

All meteorological works of Provincial Stations are conducted in uniform system throughout the Empire; the kinds of instruments to be used and their arrangements, methods of observations and calculations, and forms of all reports are determined by the Director of the Central Observatory. This report contains the annual results of meteorological observations of all stations for the recent five years since 1886, in which no distinctions being made between the first and second order, all observations have been taken at 2^h am, 6^h am, 10^h am, 2^h pm, 6^h pm and 10^h pm daily. The contents are air pressure, air temperature, tension of vapour, relative humidity, wind direction, wind velocity, precipitation, cloud direction, cloud speed, cloud amount, cloud forms, days of different kinds of weather and various miscellaneous notes.

VI. Report on earthquake observations in Japan, 1885-1890.

Seismometrical observations were for the first time made in 1875 in the Section of Land Survey of the Geographical Bureau at *Aoicho*, *Tokio*, where the *Palmieri's* Seismograph was employed. Since 1884, the *Milne-Gray's* Seismograph has been used; in the next year, the forms of earthquake record were distributed from the Observatory to each Station and Local Districts Office in which the methods of observations and means of distinguishing intensities have been explained, and in June 1891, all Provincial Stations were ordered to report by telegrams on every earthquake occurrence, its exact time and intensity. This report contains all observations made either by instruments or by feelings in about four hundred localities during the period of six years (1885-1890), and the results of seismometric observations at Tokio since its beginning, the headings treated being frequency of earthquakes, areas, time, intensity and its distribution over the Empire.

Number of earthquakes experienced on the whole country during these six years are 3,842, annual mean 640 and daily mean 1.7; the maximum frequency falling in August. However on July 28th 1889, *Kumamoto* was visited by a great earthquake which has been followed by incessant shocks over a considerable length of days, so that the mean of six years has been affected very much. Rejecting this we have obtained a monthly mean 49, the maximum being in May (65), the minimum in August (42); in intensities we have 55 % of slight, 38 % of feeble and 7 % of heavy shocks (falling down of lightly placed bodies or producing cracks in walls), the maximum heavy shocks occurring in February and April, the minimum in June.

VII. Specimen of Tri-daily Weathermaps.

On February 16th in 1883, a system of regular meteorological telegrams, once a day, was organized, thereby daily weathermaps published at the Central Observatory. From July 1st in 1884, tri-daily regular telegrams, viz, 6^h am, 2^h pm and 9^h pm (that was changed to 10^h pm on January 1st 1892), have been received at the Observatory from the Provincial Stations and tri-daily weathermaps (4 pages) published; storm warnings and weather predictions are all based on these data. On three pages out of four, isobars, isotherms, direction and force of wind, state of weather and warned districts are drawn, and readings of barometer, thermometer, wind direction, wind force, amount of precipitation, maximum and minimum temperature with changes for 24 hours and also foreign telegrams are tabulated in one page; in its bottom weather forecast for each meteorological district and storm warnings, if necessary, are inserted in abbreviated and legible form of language. These are the specimen of weathermaps and they explain the cyclonic storms visited our country in autumn and winter seasons. We intentionally selected them on September 14th and December 5th 1891, as they furnish themselves the most favourable examples.

VIII. Report on the areas of low and high pressure in Japan, 1883-1890.

Commencement of simultaneous meteorological observations and publications of daily weathermaps in Japan were alike in 1883, accordingly the business relating to the investigation of our storms was inaugurated in that year. This report contains solely the results relating to the movements of low and high areas of pressure, experienced during eight years since 1883. It is classified to areas of low and high pressure, days of gales, days of heavy rains, verifications of indications and storm warnings, together with isobaric, isothermal and precipitation charts for monthly and annual means during that period. The following are the percentage of mean verifications of indications and warnings experienced during eight years :—

Month	Indications of Weather	Indications of Wind direction	Storm warnings
January	84	77	71
February	81	84	67
March	80	79	77
April	78	75	65
May	75	80	67
June	79	80	66
July	85	85	54
August	86	85	69
September	82	79	65
October	80	82	65
November	83	69	76
December	84	83	74
Mean	82	81	76

IX. Charts showing seasonal distributions of air pressure and wind over Japan.

Although an earliest establishment of stations refers to the year 1872, the observations of a majority of stations now existing in Japan do not extend over ten years, therefore the corrections have been applied to them, by an interpolation comparing with adjacent stations experienced over ten years. The Charts are prepared by all these documents and adopting foreign observations such as at *Fusan*, *Jenchuan*, *Yuensan* in Corea, and at *Vladivostok* and *St. Olga* in Siberia. Other charts are also treated in the same manner. The Charts show seasonal distribution of air pressure and wind direction, the necessary corrections of pressure relating to altitude and gravity having been applied; wind directions given by percentage in eight points of compass, their mean directions being represented by arrows, number of calms by the size of a circle in the centre. Now we proceed to give some description of the Charts.

In winter, the high pressure area covers over the Asiatic Continent, north of Corea, and the low area lies over the Northern

Pacific Ocean. The isobaric lines run almost north and south, the barometrical range reaching as much as eight millimetres, thereby we experience in winter strong north to westerly winds frequently. But in summer, on the contrary the low area lies over the Continent and the high displays over the Pacific, the isobaric lines slightly inclining towards the northeast, the range being only two millimetres. Accordingly light south to easterly winds generally prevail in this season. In other two seasons—spring and autumn, it may be safely said that the distributions of pressure and direction of wind are as it were in midway between the changes in winter and summer.

The extreme readings of barometer and wind velocity noted since the beginning of this service are the following:—

Maximum air pressure 779.8 mm on February 2nd 1883, at *Nemuro* in Eastern *Hokkaido.*

Minimum air pressure 713.1 mm on September 14th, 1891, at *Nagasaki* in *Kiushu.*

Maximum wind velocity 43.2 m. p. s. October 10th, 1891, at *Settsu* in Western *Hokkaido.*

X. Charts showing seasonal distributions of air temperature and weather over Japan.

The Charts are intended to show seasonal distributions of air temperature and weather. Temperature in centigrade degrees is represented by means of isothermal lines, and number of days of different kinds of weather by area of a circle drawn just on the position of a station; an area of outer circle proposed to denote whole number of days of weather in one season and divided into three sectors that are designed to illustrate respectively proportional number of clear, fair and cloudy days, and inner circle to point out proportional number of rainy days. A general meteorological feature to be learned from these Charts is epitomized at some length. In winter, the mean temperature ranges from 18° in *Bonin* Island to-7° in Central *Hokkaido*, its difference 25°, and the isothermal lines run northerly almost along the coast, so that the inland is colder in this season than the coast. In summer, the mean temperature is highest also in *Bonin* Island (27°), lowest at *Nemuro* (15°), the range being only 12°, and the isothermal lines flow in southerly direction along the coast that brings out the fact just opposite to winter, the inland warmer than the coast. The thermal condition of spring and autumn is to be considered as the intermediate status coming between winter and summer.

The extreme temperatures noted since the beginning of meteorological works in Japan are

Maximum temperature 37.°5 C on August 19th, 1886, at *Hiroshima*, in the Inland Sea.

Minimum temperature —36.°7 on January 29th, 1891, at *Kamikawa* in Central *Hokkaido.*

As regards to the weather, in winter, we experience much rain or snow and least clear or fair days along the sea of Japan, while the occasion is reversed along the Pacific Coast; but, in summer, rainy days are most and fair least in Southern Japan; mostly fair weather enjoyed in Northern District.

XI. Charts showing seasonal distributions of amount of precipitation.

The Charts show seasonal distributions of amount of precipitation. It has been prepared by comparing observations of each provincial station, with no less than one hundred and fifty lighthouses and rainfall stations. We will now give the gist of its distribution. We have abundant rain as compared with neighboring countries, the average fall at places of the Extreme South reaching 3 metres in the year. In winter there measured 400-800 mm along the Sea of Japan, only 100-300 mm on the south coast, but in summer we had 800-1,000 mm on the south coast while in the Inland Sea and Northern Japan the amount did not exceed over 200-400 mm.

The extreme amount of precipitation noted since the opening of meteorological services in Japan are:

Maximum amount for 24 hours, 900 mm on August 20th, 1889 at *Tanabe* in *Kii* peninsula.

Maximum amount for 4 hours, 177 mm on April 2nd 1891 at *Naha*, in *Liukiu*.

Maximum amount for 1 hour, 54 mm on December 28th, 1890 at *Kumamoto* in *Kiushu*.

XII. Charts showing frequency of Earthquakes in Japan, the great earthquakes of Kumamoto and Mino-Owari.

The Chart shows annual frequency of earthquakes in Japan, prepared from the means of 6 years since 1885, the region covered by closed lines interpreting the most frequented places. This gives a general idea that the frequency of earthquakes is greater along the Pacific Coast, that is, from Southern *Kiushu* up to the east extremity of *Hokkaido*, than along the Sea of Japan, most conspicuous near *Tokio*, and the least frequency in *Tsushima*.

The violent shocks since the great earthquake of *Yedo* (November 11th 1855), have been as follows:—

On March 5th 1864, in the provinces of *Tamba* and *Harima;*

On March 14th 1872, in the province of *Iwami* and *Izumo;*

On July 28th, 1889 at *Kumamoto;*

On October 28th, 1891 in the province of *Mino* and *Owari*.

As the former two refer to the dates before the establishment of regular services, we are unable at present to trace any of their particulars, but with regard to the *Kumamoto* and *Mino-Owari* earthquakes, as we had an ample opportunity to investigate their occurrences, much time has been devoted to its researches, consequently many important data are now all at hand. Thereupon the separate charts have been prepared to show their intensities. The *Kumamoto* earthquake occurred at 11.^{h}40^m pm on July 28th 1891, and extended to the western extremity of *Honshu* (Nippon) in east, the area calculated approximately 10,000 square kilometres, wherein 1,500 square kilometres have been the parts violently shaken, destroying 400 dwellings, killing 20 persons, injuring 74. Near the epicentric region the earth crust produced many cracks, from which sand and mud have been emitted; the largest splits reaching the length of 1,300 metres, the breadth 6 metres. After this great earthquake, the people have experienced many successive shocks, amongst which on July 29th and 30th, numbers noted were 62.

The occurrence of the *Mino-Owari* earthquake was at $6^h\ 38^m$ am on October 28th 1891. Its area was nearly 240,000 square kilometres, comprising *Gifu* in the epicentre; the region extended from *Owari* Bay in the Pacific Ocean to *Tsuruga* Bay in the Sea of Japan has been the most seriously damaged which are assuredly told to have been the greatest distress during past 40 years. The most violent shocks covers the area of about 1,000 square kilometres; indeed within this space grounds sunk in, mountains destroyed, dwellings upset, rails damaged, bridges fell down, were innumerable. Their important figures are summed up thus:

Death 7,273; Injured 17,175; Houses destroyed 142,177; Houses partially destroyed 80,324; Bridges fell down 10,392.

During several months, this great earthquake has been followed by incessant shocks in the district severely shaken, a certain occasion bringing several hundreds in a day. Even now after 15 months elapsed from the occurrence, we are experiencing 2 or 3 times every day.

XIII. The Climate of Japan.

This volume embodies the results of all kinds of observations taken at each station since the inauguration of our official meteorological services and discusses fully about our climate and the changes of meteorological elements. The different headings of this volume are as follows:—

INTRODUCTION.—General geographical description of Japan.

CHAPTER I.—Air Temperature:
Diurnal and annual variations and its distribution over Japan, extremes, ranges and miscellaneous.

CHAPTER II.—Atmospheric pressure:
Diurnal and annual variations, extremes and its distribution over Japan.

CHAPTER III.—Wind:
Diurnal and annual variations, maximum velocity and frequency.

CHAPTER IV.—Humidity:
Diurnal and annual variations and extremes.

CHAPTER V.—Cloud amount:
Diurnal and annual variations, number of clear and cloudy days and sunshine.

CHAPTER VI.—Precipitation:
Diurnal and annual variations, heavy rain, frequency and its distribution over Japan.

CHAPTER VII.—Conclusion:
Mutual relations of meteorological elements and their nature of changes.

All the essays in each chapter are illustrated by exquisite and perfect diagrams or charts annexed.

XIV. Report on high level meteorological observations in Japan, 1880-1891.

Since the year 1880, the high level meteorological observations have been made during the periods of some days or over several months, by the officials of our Observatory or by our other meteorologists, was just 6 times. This report contains all the results of observations made on high mountains compared with those of lower stations, and some differences of the meteorological elements between the upper and lower air strata.

The selected high level stations during expeditions are

High Station:	Altitude:	Period of Observations.	
Fuji	3,718 m.	August, September, August,	1883 1887 1889
Ontake	3,062 m.	August,	1891
Gozaishodake	1,200 m.	September,	1888
Yamanaka	990 m.	August,	1889
Kurosawa	832 m.	August,	1891
Higashi Hoben	736 m.	August-October	1889

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LIST OF JAPANESE METEOROLOGICAL PUBLICATIONS.

Reports of Meteorological Stations:

Monthly and Annual means of observations made at $9^h 30^m$ am, $3^h 30^m$ pm and $9^h 30^m$ pm from 1874 to 1882; at 6^h am, 2^h pm and 10^h pm from 1883 to 1885; at 2^h, 6^h and 10^h am, pm from 1886 to 1891.

Reports of Meteorological Observations at Tokio:

For the lustrum 1876-1880 and for the ten years 1876-1885.

Reports of Hourly Meteorological Observations at Tokio:

For the lustrum 1886-1890.

Annual Reports of Hourly Meteorological Observations at Tokio:

For the years 1886-1891.

Monthly Reports of Hourly Meteorological Observations at Tokio:

For the years 1890-1892.

Monthly Summaries:

Tracks of low and high pressure, isobars, isotherms, rainfall, storms, etc, for the years 1883-1890.

Tridaily Weathermaps:

Daily reports, remarks, indications for the years 1883-1892.

Miscellaneous Publications:

Instructions to meteorological observers (1880)—Additional Instructions to meteorological observers (1882)—Instructions for meteorological observations (1886)—Reports of the Seismometrical observations for the years 1885-1890—Reports of the Pluviometric observations for the years 1890-1891—Some researches on the Agricultural Meteorology—Regulations on the Meteorological Telegrams—Regulations on the Meteorological Signals—Reports of the Expeditions to Mount Fuji (1888 and 1889), to Mount Gozaishodake (1888), to Mount Ontake (1891)—Organisation du Service météorologique au Japon (1889)—Low Barometer in Japan (1890).